# Explaining non-compliance in the Norwegian coastal cod fishery: an application of the multinomial logit

Jensen, Carsten Lynge; Aarset, Bernt




# Explaining non-compliance in the Norwegian coastal cod fishery: an application of the multinomial logit

| | |
|---|---|
| Journal: | *Applied Economics* |
| Manuscript ID: | APE-04-0203.R1 |
| Journal Selection: | Applied Economics |
| Date Submitted by the Author: | 30-Nov-2005 |
| JEL Code: | B23 - Econometrics\|Quantitative Studies < |
| Keywords: | Multinomial logit, fishery regulation, non-compliance |
| | |

Full title: **Explaining non-compliance in the Norwegian coastal cod fishery: an application of the multinomial logit**[1]

Running Title: **Explaining non-compliance in the Norwegian coastal cod fishery**

ABSTRACT

Establishing motive is central to the analysis of criminal behaviour. This paper analyses the range of motives for non-compliant behaviour among coastal cod fishermen. A multinomial logit model is employed to analyse the reasons that underlie various motives. The four motives compared in this study are economic, technological and social, and motives caused by bureaucracy and legitimacy problems. The economic motive is found to be most important for coastal fishermen. However, the cross-sectional data indicate that motives vary with fishing gear, vessel length, and fishermen's age. The results indicate that identifying motives for non-compliant behaviour is not straightforward but is important for reducing the extent of infringements of the regulations. Fishermen who use gill-net, seine and long line, for example, are more often motivated to non-compliance by technical problems and bureaucracy than hand-jig fishers. The study suggests that in order to prevent non-compliance behaviour, the authorities' management policy should be designed to address the problems encountered by different categories of fishers. For example, offences that are committed because of technical problems should be resolved by increasing the involvement of fishermen in the process of drawing up regulations, whereas offences motivated by economic factors should be reduced by increasing inspections.

## I. INTRODUCTION

Fish resources are managed by the authorities in order to achieve sustainable development of the fish stocks. In the EU, illegal catches have long been a serious management problem (Holden, 1996), and fisheries managers consider ways to improve fishermen's compliance with regulations. Evaluating motivation is important as a step towards preventing illegal behaviour. Non-compliance, for example, might be a result of lack of enforcement and punishment (Becker, 1968; Sutinen and Andersen, 1985). Lack of perceived fairness and appropriateness of the regulations may also play a role in motivating non-compliance (Tyler, 1990; Jentoft, 1989; Nielsen 2003). In any case, it is vital that the authorities should understand the motives that cause illegal behaviour in their search for effective policies to prevent non-compliance.

The literature on compliance in fisheries addresses economic, social behavioural, legitimacy, and moral factors for non-compliance (Sutinen and Kuperan, 1999; Hatcher *et al*, 2000; Nielsen and Mathiesen, 2003; Jentoft, 2000; Hønneland, 1999). A shortcoming of the existing literature is that technological reasons for non-compliance have scarcely been addressed at all. Squires, (1987), Kirkley and Strand (1988), Dupont (1991) Squires and Kirkley (1991, 1996), Jensen (2002) address that constraints of fishing technology have consequences for obtaining successful management in multispecies fishery. In this view the characteristics of fishing gears impose restriction on the fishermen's ability to comply with regulation. Gill net and trawl, for example, are often inappropriate for the selective harvesting of demersal species (Kirkley and Strand, 1988; Alam, Ishak and Squires, 1996, 2002), and the technological ability to harvest selectively has implications for the ability to obey by-

catch regulations. Obeying regulations may thus depend on the technological characteristics of the fishing technology employed.

The study makes two contributions to the literature. First, competing explanations that have their roots in different paradigms are tested for their contribution for explaining non-compliance among fishermen. Secondly, technological problems that create incentives for infringements are explicitly tested for, which to the best of our knowledge is a topic that has not been addressed before. We perform an empirical analysis of the motives for non-compliance, based on fishermen's choices among alternative explanations of why the regulations are violated. A multinomial logit model is used to analyse the responses of the fishers. The objective is to identify ways for the authorities to reduce non-compliance. The following section reviews a number of theories regarding the motivation of non-compliance behaviour. The empirical model used to analyse the motives for non-compliance is outlined in section III. Data and empirical results are presented in sections IV and V. A discussion of the findings and some policy implications for reducing non-compliance are presented in the final section.

## II. MOTIVES FOR NON-COMPLIANCE

Several scholars have carried out empirical analyses of non-compliance among fishermen (e.g. Sutinen, Rieser and Gauvin, 1990; Furlong, 1991; Sutinen and Kuperan, 1999; Kuperan and Sutinen, 1998; Hatcher *et al.*, 2000, 2005; Nielsen and Mathiesen, 2003). A review of the literature shows that several theories are used for explaining non-compliance in fisheries, the theories are founded on different paradigms employed for explaining human behaviour and have origins in research fields of economics (Becker, 1968), psychology (Kohlberg, 1976) and sociology

(Tyler, 1990).[2] A downside of superfluous of theories is that it becomes difficult for management authorities to decide which strategy to employ in order to reduce infringements of regulations. Motives for non-compliance among fishermen differs with backgrounds variables, for example, regional differences, differences between fishing gear, vessel size, and attitudes towards regulation, etc. We employ a multinomial logit model to reveal distinctions in motives for non-compliance among fishers. The procedure systemises information on fishermen's explanations for infringement behaviour with backgrounds variables of demography, firm-related factors and attitude factors. Another advantage of the procedure is that explanations for non-compliance founded on theories from fields of economics, sociology and psychology is tested empirically against each other.

Different motives for non-compliance behaviour are outlined in a questionnaire presented for the fishermen, and the individual respondents are asked to choose the motive that is most appropriate for them for explaining non-compliance behaviour (Table 1).

The first motive outlined is based on the premise that *economic reasoning* is a driving force for non-compliance behaviour. Becker (1968) suggests that utility-maximizing individuals might find it optimal to commit a criminal offence when the expected utility from committing the crime exceeds the utility from engaging in legal activity. Economic reasoning is used to explain non-compliance among fishermen (Sutinen and Andersen, 1985; Furlong, 1991).

The second option build on that *technological conditions* of different types of fishing gear have implications for fishermen's ability to comply with the regulations, and therefore *technological problems* as such is explaining the non-compliance behaviour

(Squires, 1987; Kirkley and Strand, 1988). The technology of gill-nets, for example, makes it difficult for the fisherman to comply with by-catch regulations and quota regulations (Alam, Ishak, Squires 1996; Thunberg, Bresnyan, Adams 1995). This is due to the fact that several species are harvested simultaneously, and the gill-net are an inefficient gear for selective harvesting. Non-compliance with by-catch regulations is also a problem for fishermen using trawl (Nielsen and Mathiesen, 2003).

The third is option is that *non-compliance by among fellow fishermen* is a main motivator for non-compliance of the individual fishermen. The significance of imitating others behaviour is founded on the theory of social behaviour, which emphasises how individual behaviour is influenced by opinions that are formed within a group. In this perspective the opinions of peers has a key influence via the moral context of the actual decisions taken at sea by fishermen (Sutinen and Kuperan, 1999, Sutinen and Gauvin, 1988).

Finally, the *bureaucracy of regulations* is a suggested as reason for infringement behaviour. The argument is that fishermen's perceptions of legitimacy and fairness of the regulations have an impact on compliance (Tyler, 1990; Jentoft, 2000; Hønneland, 1999; Nielsen, 2003). In this view, fishermen regard regulations as unfair, bureaucratic, and the law and its institutions as inappropriate, and thus as incentives for non-compliance.

The questionnaire form, where the respondents have to choose between alternative explanations for infringement behaviour, has the advantage that it gives the possibility for performing a systematic empirical analysis. The applied outcome choices for non-compliance denote an exhaustive representation of motives for

infringement behaviour based on the literature and relevant for the applied case study of the Norwegian coastal cod fishery.[3] A drawback of questionnaire form applied is that it requires a narrowing of definitions of the motives for non-compliance, but this is obtained to the benefit of providing sufficient observations to undertake an empirical analysis.

An important part of the analysis of the motives is to find explanatory factors that discriminate among motivation groups. Additional information on the respondents that can be broken down into demographic factors (age, member of fishery association, position in the firm, etc.), firm-related factors (number of fishing days, number of fishing permits, region, etc.) and attitude factors are collected. Information of value for understanding the underlying mechanisms for non-compliance is obtained by combining knowledge of motives and explanatory factors. These mechanisms are important as a means of suggesting options to reduce non-compliance for different categories of fishermen. Policy instruments that affect economic incentives, for example, might be important as a means of motivating fishermen to comply with economic conditions, whereas conditions that affect legitimacy problems might be the key to reduce non-compliance among fishermen that regard the regulatory climate as too bureaucratic.



## III. THE EMPIRICAL MODEL

The respondents' choices of alternative motives are modelled by a multinomial logit model. The respondents chose from J alternative motives (outcomes), which are indexed j=0,…J. The outcomes cannot be ranked in any way, and the multinomial

logit model is a suitable modelling device.[4] The model for determining the probability of outcome j is:

$$1)\ \Pr_{ij}(y = j \mid x_i) = \frac{\exp(x_i \beta_j)}{1 + \sum_{k=1}^{J} \exp(\beta_k x_i)},$$

where $\Pr_{ij}(y_i = j \mid x_i)$ denotes the probability that individual i chooses outcome j. $x_i$ represents exogenous variables, and $\beta_j$ are the parameters to be estimated. The multinomial logit model is based on the assumption of Independence of Irrelevant Alternatives (IIA) meaning that the odds ratio between any two choices is unaffected by any other alternative choice.[5] The IIA assumption is tested by determining whether the odds ratio between each pair of alternatives is impacted, when observations of other alternative choice are eliminated from the estimation (Long, 1997). Rejection of the assumption of independence means that biased predictions of probabilities will be obtained by the multinomial logit model.

The impact of individual regressors on the odds ratio is not obtained in (1), but these marginal effects are derived by differentiation:

$$2)\ \frac{\partial \Pr_{ij}}{\partial x_i} = \Pr_{ij}[\beta_j - \sum_{k=0}^{J} \Pr_{ik}\ \beta_k] = \Pr_{ij}[\beta_j - \overline{\beta}]$$

## IV. DESCRIPTION OF DATA

A questionnaire is administered to coastal fishermen holding licenses for catching cod, saithe, and haddock in the coastal fishery. Three hundred randomly selected respondents have answered the questionnaire based on telephone interviews. In order to secure a high likehood an honest responses assurance of individual anonymity and

confidentiality is provided. The questionnaire is designed in a form and wording that should obtain accurate responses, the accuracy is of particular importance with respect to the choice between different motives for non-compliance. In the study none of the 300 respondents have failed to respond on what motivates non-compliance behaviour.

The coastal fishermen in Norway are harvesting several species, and their motives for non-compliance may differ, depending on which species is mainly targeted. For example, the probability that a respondent indicates that regulation is bureaucratic might depend on whether the fisherman is referring to the herring fishery or to the cod fishery. This study focuses on the cod fishery, because this fishery is most valuable in terms of income for the coastal fleet. The 245 respondents analysed are those fishermen indicating that cod is the most important species for them, and that regulation of cod has a larger influence on earnings than any other species.

The summary statistics indicate that the majority of fishermen 63.5% (N=154) identify economic motives for cheating, 18% a technical reason, 6.6% the importance of other fishermen's behaviour, and 12.3% that bureaucracy is their reason for non-compliance (Table 2).

The demographic information indicates that the mean age of the respondents is 52 years, and that they are employed as skippers. The firm-related information reveals that most of the vessels involved operate for about 200 days a year, the average vessel length is 12.8 metres, the average crew size is two, and most companies are individually owned.

Four types of fishing gear are used in the coastal cod fishery: gill-net, Danish seine, long line, and hand jig. The summary statistics shows that hand jig fishermen are less

likely to identify technical and bureaucratic explanations for non-compliance than fishermen using other types of gear. The long-line fishermen are less likely to point at the influence of others as a motive for cheating. Some coastal fishermen also use purse seine gear, but respondents using this gear type target mainly herring, and they are not included.

Four regions of Norway are surveyed: the counties of Finnmark, Troms, Nordland, and the southern region. An interesting observation is that fishermen from Troms and the southern region seem more likely to refer to the bureaucracy motive as an explanation for non-compliance than fishermen from Finnmark and Nordland.

Attitude factors are measured by Likert variables, which reveal the opinions of respondents to regulatory issues. The attitude variables are based on responses on multiple-choice answers of the form: "I agree with the statement", "I partly agree with the statement", "I am neutral to the statement", "I partly disagree with the statement", or "I disagree with the statement", which are scored on a scale of 1 to 5.[6] The attitude variables are designed to into account the respondents' perceptions of different aspects of the regulations and control of the fishery. Among the aspects addressed are attitudes towards regulation of the fishery, personal experience of fishery regulations, perceptions of the fisheries authorities, and attitudes towards cheating in the fishery. The attitudes variables are important for a deeper understanding of the motives for non-compliance.

## V. EMPIRICAL RESULTS

A multinomial logit model is employed (Table 3). Maximum likelihood estimation is employed for estimating the model. The model is based on demographic and firm-

related factors and attitude factors. The regressors are exogenous with respect to the respondent's decision on what motivates non-compliance behaviour.[7]

Factors that are not significant at the p=0.10 level are removed. A likelihood ratio (LR) test testing the hypothesis, $H_0$: $\beta_i = 0$ for all $\beta$, is performed. The test statistic is defined as $2(L_1 - L_0)$, where $L_0$ is the value of the log-likelihood function when the only explanatory variable is the constant term, and $L_1$ is the log-likelihood value when all explanatory variables are included. The test statistics rejects the $H_0$-hypothesis ($H_0$: $\beta_i = 0$) in model, indicating that the variables contribute to explaining the differences in motives for non-compliance. Moreover, the IIA assumption is confirmed, meaning that the odds of any two choices are independent of the other choices.

The model includes three demographic and firm-related factors: fishermen older than 50 years, vessel's length in metres, and fishermen using hand jig fishing gear. The age of the fishermen is not statistically significant, but grouping the data between fisherman younger and older than 50 years of age is found to be significant. With respect to fishing gear, different gear types have been tested, and the data indicate that the hand jig differs from the other gear types. Several other demographic firm-related factors are tested but none of them contributed to explaining differences in motives for non-compliance. To this end it is interesting to observe that regional distinctions in motives for non-compliance are not statistically demonstrated in the data. Several of the attitude factors are significant in explaining motives for non-compliance, and these factors are included.

The individual effects of the demographic, firm-related, and attitudes variables are obtained by estimating their marginal effects (Table 4). Several interesting findings

are made. The marginal effects indicate that fishermen using hand jig gear are less likely to point to technical and bureaucracy problems as motivations for non-compliance than fishermen using other types of gear. The result is valuable in that it demonstrates that the fishing technology employed influences the motivation for infringement of the regulations. The results indicate that economic incentives should be used to reduce non-compliance among hand jig fishermen. For the fishermen using seine, gill net and long line the authorities should employ means that address economic motivation, but also means that are directed towards motives based on technology and bureaucratic frustration.

A weak indication is found for that fishermen on larger vessels are less likely to identify bureaucracy as their motive for non-compliance (Table 4). The vessel length is, however, statistically insignificant a result that follows due to multicollinearity in the model. Spearman's rank test justifies the significant correlations between vessel length and the following attitude factors: 1) perceived fairness of regulation, 2) perceived probability of a control of papers being conducted, 3) perceived probability that fishermen in general are cheating. Moreover fishermen older than 50 are less likely to identify technical conditions as reason for non-compliance behaviour.

Turning to the attitude factors, the perceived probability that the public managers conduct paper control is perceived being lower among fishermen that are pointing at economic motives for non-compliance compared to fishermen pointing at other motives (Table 4). The result confirms that low risk of being controlled creates an economic motive for non-compliance. It is also interesting that fishermen that point at economic motives for non-compliance have a low trust in that regulation is perceived as fair among fishermen in general. The economic-oriented fishermen also

anticipate the lowest rate of infringement among fishermen in general. The fishermen that are motivated by economic factors also have a low trust in that increased involvement of fishermen in the regulatory process will reduce non-compliance. The analysis reveals that fishermen that point at the economic motive for non-compliance are more likely to be influenced by increased control measures than fishermen that point at other motives for non-compliances.

Fishermen that point at technical reasons for non-compliance are most negative towards the discard of useful fish. A relatively positive attitude towards regulation is found among fishermen who emphasise technical motives for non-compliance. They are more likely to believe that the regulations are perceived as fair by fishermen, and that there is a higher probability of their papers being inspected than among fishermen who refer to the economic motive. For the authorities, it is important to realise that fishermen who mention technical grounds for non-compliance have a positive attitude to the involvement of fishermen in the regulation process in order to reduce non-compliance.

The fishermen who identify non-compliance among fellow fishermen as a reason for non-compliance are relatively negative to the idea that the authorities are managing the fisheries properly. They believe that non-compliance among fishermen is more common than is thought by the fishermen who pointing to economic and bureaucratic motives for non-compliance. Finally, about 12% of the fishermen point at the regulations as an explanation for non-compliance. These fishermen mainly use Danish seine, long line and gill net, and have the lowest belief that targeting other species than cod might help to reduce non-compliance. The reason might be that to using these types of fishing gear makes it is difficult to catch other species than cod. One might expect increasing the engagement of fishermen in the regulatory process

to reduce frustration with bureaucracy as a motive for non-compliance, but this does not seem to be case.

## VI. DISCUSSION AND POLICY IMPLICATIONS

The paper addresses the influence of various motives for non-compliance among coastal cod fishermen in Norway. The cross-sectional data show that there are various motives for non-compliance among coastal fishermen. The economic motive for non-compliance is important for most fishermen, a finding that is in line with the results of studies performed by Hatcher *et al*. (2000, 2005), Nielsen and Mathiesen (2003), and Sutinen, Rieser and Gauvin (1990). Individual economic conditions play an important role in determining the motives that lead to infringement of the regulations. In particular, we find that fishermen who emphasise economic motives believe in a lower likelihood that their papers will be inspected than fishermen who explain non-compliance in terms of non-economic motives. However, increasing fishery control has often been found to be a relatively costly way to achieve compliance (Arnason, Hannesson and Shrank, 2000). For this reason, increasing the involvement of fishermen in the regulatory process is often suggested as a means of reducing non-compliance. This study indicates that increased involvement of fishermen is likely to have a low probability of success among economy-oriented fishermen, compared to fishermen who identify technical reasons for non-compliance. The result is interesting because scholars have discussed whether means that affect economic incentives, legitimacy or technical problems should be employed to reduce non-compliance. Our findings suggest that involving fishermen in the regulatory process would reduce non-compliance among some fishermen, whereas economic conditions might be expected to influence the majority of fishermen.

The study is based on the premise that fishermen cannot be regarded as a homogeneous group, since harvesting patterns differ among fishermen, depending on regional differences in fishing fields and abundance of fish, differences in harvesting gears, which means that perceptions of regulation and motives for non-compliance also differ among fishers. The study shows that type of fishing gear plays a significant role in explaining differences in motives for non-compliance among coastal fishermen. Empirical studies by Squires (1987), Kirkley and Strand (1988) show that gear is crucial for determining production conditions and the ability to adjust to regulation. The present study shows that catch technology also plays an important role in explaining differences in motives for infringing the regulations. More specifically, we find that hand jig fishermen are less likely to suggest that bureaucracy and technical problems motivate non-compliance than fishermen who use Danish seine, gill-net and long line. The use of a particular technology influences fishermen's perception of regulations, in that it appears that hand jig fishermen perceive a higher degree of fairness of regulation than fishermen who use other types of gear. Their somewhat positive attitude to regulation explains the lower percentage of hand jig fishermen who use bureaucracy as their explanation for non-compliance compared with fishermen who use other types of gear. If we wish to understand what causes the differences in motives, it is also important to note that hand jig fishermen have fewer problems in avoiding by-catch than fishermen using Danish seine and long line.[8] Moreover, fishermen who use other gear types than hand jig indicate that periodic (temporal) regulation is the problem, while hand jig fishermen are relatively more concerned with regulation of minimum fish size.[9]

It is also interesting to note that our data do not allow us to establish regional differences in motives for non-compliance. We anticipated that the differences in

composition of harvested species and differences in fishing fields along the Norwegian coast, a distance of 2000 kilometres, would have produced different motives for non-compliance in different regions. However, the fact that most respondents are operating in the three northernmost counties of Norway (Finnmark, Troms and Nordland) under much the same harvesting conditions might explain the lack of regional differences in the data.[10]

Eighteen percent of the fishermen identify technical problems as the reason for non-compliance. These fishermen mainly use gill net, long line and Danish seine, and regard discard of useful fish as an important regulation issue. Information on how regulative obstacles are perceived by fishermen who use different gears is important if fishermen are to be involved in the regulatory process. The survey indicates that long-line, Danish seine and gill net fishermen suffer from different technical problems; for example, 40% of long-line and 28% of Danish seine fishermen regard bycatch as a major regulation obstacle, whereas mesh size seems to be a problem for gill net fishermen mentioned by 26 % of this group.

Forty percent of the respondents who mention bureaucracy as an explanation for non-compliance stress that periodical quota regulation is an obstacle. These fishermen mainly use Danish seine, long line and gill net. It seems that regulations are linked to a low faith in the possibility that orienting their catch strategy towards other species might reduce non-compliance. This result might follow because these fishermen have limited possibilities of switching their catch strategy. Periodical regulation is regarded as being unnecessarily restrictive. It is also interesting to note that fishermen who regard the regulations as bureaucratic do not believe that increased involvement of fishermen in the regulatory process would alleviate the situation. This attitude might stem from these fishermen's lack of faith in being heard

in the management process (Jentoft, 2000). Finally, it is remarkable that the fishermen who are most sceptical about public control of the fishery are the small minority who identify non-compliance among fellow fishermen as a motive for the non-compliance conducted by them. On second thoughts, however, this result is perhaps not so surprising, in that it suggests that these fishermen would probably recommend greater government control of their fellow fishermen.

REFERENCES

Amemiya, T. (1981) Qualitative response models. *Journal of Economics Literature*, **XIX**, 1483-1536.

Alam M.F., Ishak, H.O. and D. Squires (1996) Sustainable resource use, economic development, and public regulation: the multiproduct gill net fishery of peninsular Malaysia. *Environmental and Resource Economics*, **7**, 117-132.

Alam M.F., Ishak H.O. and D. Squires. (2002) Sustainable fisheries development in the tropics: trawlers and license limitation in Malaysia. *Applied Economics*, **34**, 325-337.

Arnason R., R. Hannesson and W.E. Shrank (2000) Costs of fisheries management: the cases of Iceland, Norway and Newfoundland. *Marine Policy,* **24**, 233-243.

Becker, G.S. (1968) Crime and punishment: an economic approach. *Journal of Political Economy*, **76**, 169-217.

Dupont, D.P. (1991) Testing for input substitution in a regulated fishery. *American Journal of Agricultural Economics*, **73**, 155-164.

Furlong, W. J. (1991) The deterrent effect of regulatory enforcement in the fishery. *Land Economics*, **67**, 116-129.

Hatcher, A., D. Gordon (2005) Further investigations into the factors affecting compliance with U.K. fishing quotas. *Land Economics,* **81**, 71-86.

Hatcher, A, J. Shabbar, O. Thébaud and E. Bennett (2000) Normative and social influences affecting compliance with fishery regulations. *Land Economics*, **76**, 448-461.

Holden, M. (1996) *The Common Fisheries Policy: Origin, Evaluation and Future.* Oxford: Fishing News Books.

Hønneland, G. (1999) A model of compliance in fisheries: theoretical foundations and practical applications. *Ocean Development & International Law*, **42**, 699-716.

Jensen, C.L. (2002) Application of the dual theory in fisheries: A survey. *Marine Resource Economics*, **17**, 309-334.

Jentoft, S. (1989) Fisheries co-management. Delegating government responsibility to fishermen's organizations. *Marine Policy*, **13**, 137-154.

Jentoft, S. (2000) Legitimacy and disappointment in fisheries management. *Marine Policy*, **24**, 141-148.

Kirkley, J. E. and Strand, I. E. (1988) The technology and management of multi-species fisheries. *Applied Economics*, **20,** 1279-1292.

Kohlberg, L. (1976) Moral stages and moralization, in *Moral Development and Behviour.* (Ed.) T. Likona, Holt, Rinehart & Winston, New York, Ny, pp. 31-53.

Kuperan. K. and J. G. Sutinen (1998) Blue water crime: deterrence, legitimacy and compliance in fisheries. *Law & Society Review*, **32**, 309-338.

Likert, R. (1932) *A Technique for the Measurement of Attitudes*. New York: Archives of Psychology.

Long, J. Scott (1997) *Regression Models for Categorical and Limited Dependent Variables*. Sage Publications.

McFadden, D. (1974) Conditional logit analysis of choice behaviour, in "*Frontier in Econometrics*. (Ed.) P. Zarembka. New York: Academic Press, pp. 105-142.

Nielsen, J. R (2003) An analytical framework for studying: compliance and legitimacy in fisheries management. *Marine Policy*, **27**, 425-432.

Nielsen, J. R, and C. Mathiesen (2003) Important factors influencing rule compliance in fisheries: lessons from Denmark. *Marine Policy*, **27**, 409-416.

Squires, D. (1987) Public regulation and the structure of production in multiproduct industries: an application to the New England otter trawl industry. *RAND Journal of Economics*, **18**, 234-247.

Squires, D. and J. Kirkley (1991) Production quotas in multiproduct fisheries. *Journal of Environmental Economics and Management*, **21**, 109-126.

Squires, D. and J. Kirkley (1996) Individual transferable quotas in a multiproduct common property industry. *Canadian Journal of Economics*, **29**, 318-342.

Sutinen, J.G. and P. Andersen (1985) The economics of fisheries law enforcement. *Land Economics*, **61**, 387-397.

Sutinen, J.G and J.R Gauvin (1988) Enforcement and compliance in the commercial inshore lobster fishery of Massachusetts, A Report to the Environmental Enforcement Division, State of Massachusetts.

Sutinen, J.G. A. Rieser and J.R. Gauvin (1990) Measuring and explaining noncompliance in federally managed fisheries. *Ocean Development & International Law*, **21**, 335-372.

Sutinen, J. and K. Kuperan (1999) A socio-economic theory of regulatory compliance. *International Journal of Social Economics*, **26**, 174-193.

Thunberg, E. M., E. W. Bresnyan and C. M. Adams (1995) Economic analysis of technical interdependencies and the value of effort in a multi-species fishery. *Marine Resource Economics*, **10**, 59-76.

Tyler, T.R. (1990) *Why People Obey the Law*. New Haven and London: Yale University Press.

Table 1. Motives for non-compliance with regulations among fishers

| Question: In your opinion, what is the most important reason for non-compliance with regulations |
|---|
| 1. One has to disobey the regulations in order to obtaining a reasonable income from fishing |
| 2. Technical problems make it difficult to comply with the regulations |
| 3. Because other fishermen are cheating |
| 4. Because the regulations are bureaucratic |

Table 2. Summary statistics for respondents on the survey for the coastal cod fishery in Norway

| | Economy (N=154) | Technical problem (N=45) | Others cheating (N=16) | Bureaucracy (N=30) | Total (N=245) |
|---|---|---|---|---|---|
| *Demographic* | | | | | |
| Average age | 52 years | 50 years | 48 years | 53 years | 52 years |
| Position in firm | | | | | |
| Skipper | 98 % | 97 % | 100 % | 100 % | 98 % |
| *Firm-related* | | | | | |
| Mean fishing days | 200 days | 207 days | 201 days | 196 days | 201 days |
| Mean vessel length | 12.6 m | 13.4 m | 15.7 m | 11.5 m | 12.8 m |
| Mean crew size | 1.9 men | 2.3 men | 2.6 men | 1.8 men | 2.0 men |
| Corporate form | | | | | |
| Single ownership | 77 % | 73 % | 50 % | 83 % | 75 % |
| Gear | | | % | | |
| Gill-net | 59.1 | 20.0 | 8.2 | 12.7 | = 100 % |
| Danish seine | 55.3 | 18.4 | 10.5 | 15.8 | = 100 % |
| Long line | 60.5 | 25.6 | 0.0 | 14.0 | = 100 % |
| Hand Jig | 77.8 | 9.3 | 5.6 | 7.4 | = 100 % |
| Region | | | % | | |
| Finnmark | 64.3 | 19.0 | 7.1 | 9.5 | = 100 % |
| Troms | 55.0 | 20.0 | 8.3 | 16.7 | = 100 % |
| Nordland | 69.0 | 18.0 | 5.0 | 8.0 | = 100 % |
| Southern regions[1)] | 58.1 | 16.3 | 7.0 | 18.6 | = 100 % |

1) Southern regions include the counties: Nord-Trøndelag, Sør-Trøndelag, Møre and Romsdal, Sogn og Fjordane, Hordaland, Rogaland, Vest-Agder.

Table 3. Estimates made using the multinomial logit model

| | Outcome 1 Economy | Outcome 2 Techn. Probl. | Outcome 3 Other cheat | Outcome 4 Bureaucracy |
|---|---|---|---|---|
| Constant | | -3.813** | -3.967* | -2.226 |
| | | (-2.73) | (-1.90) | (-1.35) |
| Age_50 | | -0.952** | -1.327** | 0.402 |
| | | (-2.32) | (-1.99) | (0.85) |
| Meter | | -0.042 | 0.073 | -0.084** |
| | | (-0.95) | (1.21) | (-1.51) |
| Hand Jig | | -1.342** | -0.323 | -1.266** |
| | | (-2.16) | (-0.38) | (-2.09) |
| 1. Attitude to public | | 0.136 | -0.392 | 0.134 |
| control | | (0.88) | (-1.63) | (0.80) |
| 2. Attitude to discard | | -0.294** | -0.138 | 0.299 |
| | | (-2.10) | (-0.51) | (1.21) |
| 3. Fishermen perceive | | 0.016** | 0.032** | 0.010 |
| regulation as fair | | (2.44) | (3.07) | (1.43) |
| 4. Perceived risk of | | 0.019** | 0.018 | 0.003 |
| papers being checked | | (2.47) | (1.55) | (0.37) |
| 5. Attitude towards | | 0.090** | 0.099** | 0.055 |
| cheating of fishermen | | (3.23) | (3.17) | (1.69) |
| 6. Attitude towards | | 0.572** | 0.099 | 0.175 |
| fishermen's involvement | | (2.34) | (0.30) | (0.82) |
| 7. Harvesting of | | 0.074 | -0.019 | -0.471** |
| alternative species | | (0.33) | (-0.06) | (-2.47) |
| LR test on all variables $\chi^2(9)^{1)} = 97.65$* | | | | |
| IIA Test | 14.41* | 9.69* | 11.76* | 11.79* |

Note. Reference outcome 1 (economy). For outcome 1 the economics are used as a comparison group.
Note. ** indicates significance at 5% level, and * indicates significance at the 10% level. Figures in parenthesis are the t-statistics.

1) A LR test with $H_0$: $\beta_i = 0$.

Table 4. Marginal effects

| | Outcome 1 Economy | Outcome 2 Technical problem | Outcome 3 Other cheating | Outcome 4 Bureaucracy |
|---|---|---|---|---|
| Age_50 | 0.105 | -0.122** | -0.041 | 0.058 |
| | (1.56) | (-2.29) | (-1.63) | (1.41) |
| Meter | 0.009 | -0.004 | 0.002 | -0.007 |
| | (1.31) | (-0.78) | (1.41) | (-1.50) |
| Hand Jig | 0.202** | -0.114** | -0.001 | -0.086** |
| | (3.30) | (-2.61) | (-0.07) | (-2.30) |
| 1. Attitude to public | -0.016 | 0.016 | -0.012* | 0.012 |
| control | (-0.67) | (0.88) | (-1.74) | (0.77) |
| 2. Attitude to discard | 0.008 | -0.039** | -0.003 | 0.034 |
| | (0.32) | (-2.37) | (-0.47) | (1.51) |
| 3. Fishermen perceive | -0.003** | 0.001** | 0.0008** | 0.0006 |
| regulation as fair | (-2.67) | (2.16) | (2.43) | (0.93) |
| 4. Perceived risk of | -0.002** | 0.002** | 0.0004 | -0.00001 |
| papers being checked | (-3.01) | (2.47) | (1.26) | (-0.02) |
| 5. Attitude towards | -0.015** | 0.009** | 0.002** | 0.003 |
| cheating of fishermen | (-3.08) | (2.92) | (1.97) | (1.19) |
| 6. Attitude towards | -0.074** | 0.066** | -0.0001 | 0.008 |
| fishermen's involvement | (-2.19) | (2.37) | (0.001) | (0.39) |
| 7. Harvesting of | 0.030 | 0.016 | 0.0006 | -0.048** |
| alternative species | (0.95) | (0.63) | (0.07) | (-2.60) |

Note. ** indicates significance at 5% level, and * indicates significance at the 10% level. Figures in parenthesis are t-values.

1 Suggestions by an anonymous referee have substantially improved the paper. Communication with Stein Arne Rånes is greatly appreciated. The authors wish to acknowledge the financial support of the Research Council of Norway. The views expressed herein are those of the authors and are not to be attributed to the Research Council.

[2] Sutinen and Kuperan (1999), Hønneland (1999) provide an enriched theoretical introduction to the literature applied for explaining non-compliance in fishery.

[3] The applied outcomes are designed to cover the most likely explanations for non-compliance behaviour among Norwegian costal fishers and for securing accuracy in responses, we have formulated the motives in a wording to be well understood by the fishermen. None of the respondents failed to decide on what motivates non-compliance behaviour.

[4] Choices that cannot be ranked in any way are denoted as unordered (see Amemiya, 1981).

[5] An example of rejection of the IIA in the literature is obtained in the red bus/blue bus example, where the odds of transportation choice between car and red bus will be affected when transportation with a blue bus is added as an option. The red and blue buses are naturally close substitutes, and therefore the odds between red bus and car will be reduced, when the blue bus is added as an option (McFadden, 1974).

[6] The Likert variable is used as a device for transforming attitudes with categories like strongly approve, approve, undecided, disapprove, and strongly disapprove into quantitative variable with numeric values between 1 and 5 (Likert, 1932).

[7] A referee suggests that a Hausman test might provide a suitable device for testing the exogeneity of the regressors. The procedure builds on the use of exogenous instruments that are correlated with the regressors without being correlated with the regressant. Unfortunately, those instruments are not at hand, which prevents us from performing the suggested test.

[8] 33% of the fishermen using hand jig mention that avoiding bycatch in the cod fishery is not easy, for seine and long line the percentages are 65% and 53% respectively.

[9] The questionnaire also reveals that periodical regulation is regarded as a problem for 29% of fishermen not using hand jig, but is regarded as a problem by only 9 % of the fishermen using hand jig. On the other hand, while 27% of the hand jig fishermen mention that minimum size is an important regulatory problem, this issue is only mentioned by 7 % of other fishers.

[10] Eighty-two of the respondents operate in the Counties of Finnmark, Troms and Nordland.